INTERIM STORMWATER QUALITY CONTROL GUIDELINES

FOR

NEW DEVELOPMENT

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1.0 INTRODUCTION

This document has been prepared jointly by the Ontario Ministries of Environment (MOE) and Natural Resources (MNR) to address stormwater quality requirements in developing areas of the Province. The management of stormwater encompasses flooding, erosion, fisheries, groundwater recharge, and water quality. Stormwater mandates of the two Ministries address the prevention of loss of life, minimization of community disruption and property damage due to erosion and flooding and the maintenance and enhancement of surface and ground water resources, sufficient for aquatic life, recreation and other uses.

- *The goal of the Interim Stormwater Quality Control Guidelines is the protection and enhancement of pre-development hydrologic and water quality regimes.*

Specifically, the application of the guidelines will:

- provide municipalities with needed information for the preparation of planning documents and the review of planning proposals that ensure that stormwater management systems appropriately address water quality control.

- provide direction to development proponents for the preparation of master drainage and stormwater management plans for water quality control.

- provide guidance to MOE and MNR staff who evaluate and approve stormwater management facilities, stormwater management and master drainage plans for stormwater quality control.

2.0 THE NEED FOR STORMWATER QUALITY CONTROL

The proper control of drainage from urban areas is a concern of developers, municipalities, conservation authorities and provincial agencies. Existing practices and designs for servicing municipalities are intended to efficiently direct stormwater towards surface waters and transport it downstream. While affording desirable protection against the loss of both property and life, it is widely accepted that these practices degrade water quality and result in the reduction or loss of associated water uses (i.e., swimming, fishing and outdoor recreation etc.).

URBAN DEVELOPMENT

- *changes in landuse;*
- *changes in landuse activities;*
- *changes in drainage systems.*

Results:

- *increased density of drainage networks;*
- *increased surface runoff volumes and peak flows;*
- *higher surface flows;*
- *lower baseflows;*
- *increased frequency of more severe runoff events;*
- *increased pollutant loadings; and,*
- *increased surface water temperatures.*

Continued intensification of urban growth and development in Ontario has aggravated water quality problems, both with respect to the number of water courses affected and the magnitude of the problem (i.e., degree to which water quality is impaired).

URBAN RUNOFF QUANTITY CONSIDERATIONS

- *percent imperviousness of watershed is the most important factor in determining quantity of runoff.*

- *urbanization increases imperviousness of watershed.*

- *small frequent storms produce little if any runoff in natural catchments.*

TABLE 1 - URBAN STORMWATER POLLUTANT CONSTITUENT CONCENTRATIONS

Parameter	U.S. EPA[1]	East York[2]	St. Catharines[3]	Kingston[4]	Provincial Water Quality Guidelines
Total Suspended Solids (mg/L)	125	281	250	72	-
Biological Oxygen Demand (mg/L)	12	14	8.2	8.5	-
Chemical Oxygen Demand (mg/L)	80	138	-	-	-
Total Phosphorus (mg/L)	0.41	0.48	0.33	-	0.03
Soluble Phosphorus (mg/L)	0.15	0.06	0.084	0 118	-
Total Kjeldahl Nitrogen (mg/L)	2 00	2 20	0.89	-	-
Nitrate and Nitrite (mg/L)	0.90	0.46	0.65	0.25	-
Total Copper (mg/L)	0.040	0.050	0.021	0.009	0 005
Total Lead (mg/L)	0.165	0 570	0.084	0.013	0 025
Total Zinc (mg/L)	0.210	0.330	0.100	0.064	0.030
Fecal Coliform (org/100 ml)	21,000	11,000	68,000	21,000	100

1. U.S. EPA - Mean concentration for median urban site
   Nationwide Urban Runoff Program (NURB) (Driscoll and Mangarella, 1990)
   - Fecal coliform, Median Event Mean Concentration (EMC), 11 sites
   NURP (U.S. EPA, 1983)
2. East York - Arithmetic mean, 18 events, 1 site (Kronis, 1982)
3. St. Catharines - Geometric mean, 4 events, 1 site (SCAPCP, 1990)
4. Kingston - Geometric mean, 8 events, 1 site (CH2M Hill, 1990)

The Ontario Water Resources Act includes stormwater in its definition of "sewage". Environment Ontario has the power under Section 24 of this act to review and approve stormwater treatment works.

Ministry of Environment water quality abatement programs in the 60's, 70's and early 1980's focused on the impact of point sources of urban pollution, such as municipal and industrial wastewater treatment facilities. Abatement actions which followed these studies resulted in substantial water quality improvements, particularly for total phosphorus, bacteria and dissolved oxygen. From more recent studies, an appreciation of the importance of non-point sources of pollution was gained, especially the role of stormwater and its cumulative impact. These studies (Toronto Area Watershed Management Study, Rideau River Basin Study, Metro Toronto Remedial Action Plan, Kingston and St. Catharines Pollution Control Plans) demonstrated that contaminated stormwater was a major contributor to the degradation of water quality, restriction of water uses and the destruction of fish stocks and aquatic habitats.

Urban stormwater runoff carries a wide range of pollutants. Variabilities in the composition of stormwaters, the sources of these contaminants and resultant loading estimations are recognized in the presentation of average pollutant concentrations in Table 1. Marsalek and Ng (1989) suggest that the variations in stormwater pollutant concentrations should be considered in the context of intended use of such data, e.g., comparison of relative contributions of pollutant sources and the development of cost effective remedial measures.

Parameter selection for Table 1 was based on commonly monitored parameters known to be significant contributors to water quality problems. Organics and pesticides are not shown due to the shortage and inherent variability of these data.

The above named studies also demonstrated the *remediation* of urban water quality and water uses may be extremely expensive, and achievable only over long periods of time. Even then, there are certain restrictions or limitations with respect to clean-up of these waterbodies and the restoration of desired water uses.

NON-POINT SOURCES

"Historically, control of urban point sources (i.e., municipal and industrial wastewaters) has received primary attention in water pollution abatement. However, there is growing concern over the significance and need for control of non-point sources of pollution (including atmospheric input of pollutants). Accordingly, in establishing effluent requirements for point sources, consideration must be given to the effects of contaminant inputs from non-point sources on receiving water quality. Conservation and remedial measures will be required for the control of non-point sources if they are shown to cause or contribute significantly to violations of the Provincial Water Quality Objectives."*

Source: MOE 1978 (revised 1984) Water Management Goals, Policies and Implementation Procedures.

* *Stormwater is a non-point source pollutant.*

When an urban waterbody is polluted, certain water uses are either lost or restricted. For example residents may be unable to swim, fish, boat or to enjoy more passive recreational activities such as hiking or picnicking. A second less tangible constraint is the loss or reduction in intrinsic benefits associated with a clean waterbody. An example is public expectation and insistence that surface waters are clean and safe to use. A related consideration is the cost or inconvenience of providing, or meeting desired water uses at alternate locales. For example the expense and time required to travel to outside areas (natural uses), the provision of swimming pools, water fountains, ponds and water amusement parks or the disinfection of beaches.

Beneficial uses of stormwater include: aesthetic landscaping, lawn and garden watering, washing, cooling and fire protection. Stormwater can also have an important role in the maintenance of base flows, cool summer water temperatures and groundwater recharge.

Stormwater should be viewed in the context of a resource to be managed and used in support of societal benefits, as opposed to the traditional approach - a waste to be drained and disposed of as quickly as possible, i.e., water conservation. The growing problem and expense of providing adequate water supplies and industrial/municipal wastewater disposal is an additional incentive to explore beneficial uses of stormwater. Further research is needed in stormwater reuse techniques (processes, operations and management) for ornamental and recreational scenery purposes.

3.0 PLANNING AND IMPLEMENTATION CONSIDERATIONS

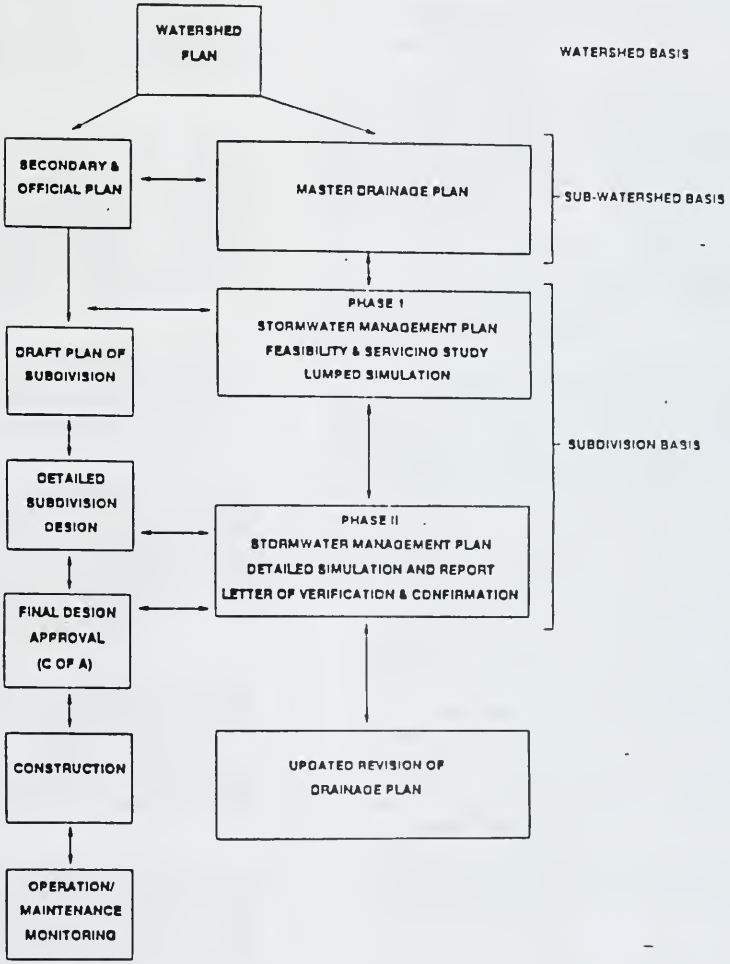
As a first step the Interim Stormwater Quality Control Guidelines are intended to assist with the planning, design and implementation of stormwater works. In addition, the guidelines are written to promote research and to encourage the demonstration and application of technically sound and innovative solutions.

The Interim Stormwater Quality Control Guidelines are a part of a provincial strategy for management of urban watersheds being formulated jointly by MOE/MNR. Interim Stormwater Quality Control Guidelines are to be considered in conjunction with Watershed Management, Master Drainage and Stormwater Management Plans, and Municipal Planning documents whose roles are outlined in Figure 1.

Stormwater quality control should be co-ordinated throughout the land use plan review process and considered at all stages of planning and development. A high degree of co-operation and understanding will be necessary on the part of the developer, municipality, conservation authority and

FIGURE 1

AN INTEGRATED APPROACH FOR WATERSHED MANAGEMENT
LAND USE PLANNING AND STORMWATER MANAGEMENT



SOURCE: BEST MANAGEMENT PRACTICES , MOE 1991

provincial agencies. A lack of co-operation can lead to, and in the past, has resulted in costly and complex pollution and drainage problems, and delays in the development approval process.

Official plans set out objectives and policies which the municipalities use to guide development. It is recommended that municipalities make a commitment in their official and secondary plans to protect or enhance the water uses identified in the Watershed Management Plan. In addition municipalities should undertake comprehensive planning for stormwater quality control and that this planning should be an early element of landuse planning.

Watershed Management Plans will define existing and potential uses for specific segments of the watercourse and will identify supporting requirements, e.g., hydrology, biology, groundwater and stream morphology components. Master Drainage Plans address requirements for stormwater quality and quantity management at the sub-watershed scale.

In areas lacking Watershed Management Plans, municipalities and proponents of new development will be required to determine existing and potential water uses and any requirements for the protection of the environment.

Secondary Plans provide detailed land use plans and policies for a portion of the area covered by the Official Plan. If a secondary plan is to be prepared it should be done concurrently with a Master Drainage Plan. The Master Drainage Plan would include water quality requirements as set out in this document and by other agencies.

Stormwater quality controls should be considered at an early stage in the subdivision planning process (Plan of Subdivision) since these controls will significantly affect the layout of lots in a subdivision. Subdivision planning should not be undertaken independently, nor should each subdivision necessarily have its own stormwater quality control facilities.

Stormwater Management Plans prepared by the developer should be based on the requirements of the Watershed Management Plans, Master Drainage Plans, Official and Secondary Plans. These plans should indicate the impact of the proposed development on water quantity and quality, discuss any proposed mitigation measures to overcome drainage problems and ensure integration with the Master Drainage Plan.

Stormwater quality management does not end when the last house is built. Municipalities will be required to operate and maintain stormwater quality facilities and practices once the development activities are complete.

4.0 GUIDELINES FOR WATER USE PROTECTION

In developing these guidelines, the two ministries have taken steps to provide directions for the integration of quantity and quality in the management of stormwater and to incorporate guidance for the protection of baseflows and groundwater supplies.

The document additionally considers that stormwater planning conform to or consider broader base objectives, such as ecosystem management, sustainable development and no net loss of fisheries or fish habitat.

In new developing areas proponents will be required to indicate the effects of their development, to look for opportunities to improve and to provide acceptable mitigative measures to ensure that surface waters are of a quality which is satisfactory for aquatic life and recreation.

The guidelines for the water quality control of stormwater were developed on four principal considerations:

- That initial storm runoff is typically high in pollutants accumulated during antecedent dry periods.
- That source controls must be employed to minimize the contamination of storm runoff at the source.
- That it is essential to reduce the volume of storm runoff moving off site.
- That the control of storm runoff is to be approached from a volume, frequency and duration perspective.

PLANNING AND DESIGN OF STORMWATER RUNOFF SYSTEMS

Urban drainage planning and designs should adopt the following concepts:

- *site drainage to the receiving watercourse should maximize the use of overland flow networks through the use of grassed swales, natural channels, infiltration trenches and basins, and wetlands.*
- *natural drainage/overland flow of stormwater runoff should be integrated with open space and park dedication.*
- *planning and design of stormwater runoff systems must take place at early stage of the development/construction process in order to capitalize on regional opportunities.*

Source controls for the control of stormwater from industrial and residential sites include: on site reduction of pollutants, indirect site drainage (i.e., lot grading, grass swales or constructed wetlands, natural channel designs and techniques which maximize infiltration), spill controls and the elimination of direct roof connections to storm sewers. Figure 2 explains differences between structural and nonstructural source controls. Whenever possible, drainage designs for stormwater should maximize the use of surface drainage as opposed to sewer systems.

This document presents directives for stormwater quality management which concentrate on the control of suspended solids and bacteria. Since many pollutants present in stormwater are directly associated with suspended solids, the control of nutrients, trace metals and organics may, to a certain extent, be realized in terms of reduced suspended sediments.

Stormwater control design guidelines and the suggested approach for the integration of quality and quantity in the control of stormwater can be implemented within legislative, policy and administrative procedures already in place. Stormwater management schemes which integrate source controls, offline storage and treatment are recommended, and may prove to be both cost-effective and successful.

The Interim Stormwater Quality Guidelines are intended to encourage proponents of new developments to investigate and apply technically sound and innovative approaches in their management of stormwater. This document is entitled "Interim" to reflect the intention that the guideline will be reviewed periodically by the two ministries and updated as new water quality assessments and management technologies for stormwater are developed and evaluated.

In addition to MOE/MNR efforts in the development of stormwater management guidelines and design manuals, conservation authorities, developers and their consultants are encouraged to continue their own research and to bring forward innovative approaches for the management of stormwater.

The preceding sections introduced underlying philosophical, technical and implementation considerations for the quality control of stormwater. This section expands on the "how to" aspects of controlling stormwater from a quality perspective.

Technologies for the infiltration of stormwater and the reduction of pollutants on site, are available and are being evaluated by MOE and MNR. Technical reports, scientific literature and conference proceedings are available for consultation. (See expanded reference list.)

Hydrogeology studies will be required to establish the appropriateness of stormwater infiltration techniques. These studies will define on the basis of groundwater sensitivities, suitable soils and volume(s) of stormwater which can be infiltrated. Infiltration options must comply with MOE's Reasonable Use Policy. 15-08.

Guidelines for stormwater quality control are presented in Table 2 and include requirements for buffer zones and setbacks, volume control, and water use protection. At present, the guidelines for controlling stormwater are based upon best professional judgments, with respect to practicality and performance.

There will be certain sensitive areas in the Province where development may not be feasible regardless of the level/extent of stormwater management.

RELATED DOCUMENTS

- *Guidelines on Erosion and Sediment Control for Urban Construction Sites.*
- *Urban Drainage Design Guidelines.*
- *Model Sewer Use By-Law.*
- *Guidelines on the Design and Development of Instream Works.*
- *Fisheries Management Plans.*
- *Guidelines on Design and Development of Buffer Strips Along Lakes and Streams.*
- *Guidelines on Design and Development of Utility Corridor Crossing of Streams.*
- *MTO Drainage Policy and Practices Guidelines.*
- *Design and Construction Guidelines - Drainage Act.*
- *Class Environmental Assessment Documents.*
- *Provincial Policy Statements on Wetlands.*

In the spring, snowmelt and precipitation combine to produce the greatest loadings of sediments and sediment bound pollutants from a watershed (Bodo, 1989). Fall precipitation events and early winter freeze/thaw cycles generate large runoff volumes which transport seasonally significant sediment loads. The important point, is that these runoff events are natural and take place irrespective of landuse. Landuse activities tend to alter the volume of transported sediments and influence the degree to which the eroded sediments are polluted.

From a stormwater quality perspective, the question is whether to approach basin loading to lake systems by storage-treatment or to control on-site erosion and contamination. The latter approach is favoured since it does not attempt to store/treat the huge volume of water naturally transported each spring and fall.

Stormwater quality control guidelines are provided for the protection of coldwater and warmwater fisheries and selective water uses (e.g., recreation and aesthetic uses). MNR District Fisheries Management Plans classify Ontario's waterbodies (lakes, streams) as either cold or warm water habitats. This classification is based on summer water temperatures and resident fish communities. Coldwater streams and lakes contain fish communities consisting of a mixture of salmonids (trout, salmon) and warm water tolerant species (smallmouth bass, sunfish, bullheads). Warmwater fish communities do not include resident salmonids.

Coldwater fish communities have stringent (i.e., sensitive) habitat requirements - thus the rationale for stringent stormwater quality controls to protect these streams/lakes. The less stringent controls advocated for warm water streams are deemed adequate to maintain/enhance these fishery. More stringent controls may be required for significant or sensitive warm water fisheries on a case-by-case basis.

Water use protection guidelines identified in Table 2 are *in addition* to the stormwater quality control guidelines for fishery protection. As the need arises, additional water use protection guidelines for control of stormwater will be established by MNR/MOE.

Water uses are to be defined in Watershed Management Plans prepared by local Conservation Authorities with input from Ministry of Natural Resources and Environment Ontario. Where Watershed Management Plans have not been prepared, proponents of new development and municipalities will be required to provide an assessment of the waterbody and to meet with Conservation Authorities, MNR and MOE to determine existing/potential water uses and any requirements for the protection and enhancement of these resources.

IMPLEMENTATION

- *Stormwater quality control should be coordinated with land use planning and considered at all stages of the planning and development process.*
- *MOE and MNR to provide technical assistance to municipalities and developers in the preparation of planning documents and development applications.*

BUFFER ZONES

In accordance with established MNR requirements a minimum of either 15 or 30 horizontal metres of land from a waterbody must be retained with natural vegetation during all phases of development. Buffer zone widths as specified in Table 2 vary according to the type of fishery sustained by the stream. Where no vegetation exists within the buffer zone, due to poor land management, revegetation will be required. To ensure that buffer zones are not damaged during the construction phase, they must be clearly marked and protected.

More stringent buffer requirements may be necessary for stream corridors with sensitive soil conditions (i.e., high permeability, shallow depths or extensive organic soils) in order to maintain the integrity of the watercourse. Once the development activities are completed, the municipality/ conservation authority will resume responsibility for the management of established buffers.

SETBACKS

Zoning bylaws can be used to identify specific setbacks for lots, thereby providing for the protection of areas adjacent to buffers. To be effective, stormwater management techniques such as buffer zones and setbacks must be required and enforced by the municipality through zoning bylaws.

Site plan controls adopted in official plans can be used effectively to:

1. specify the location and maintenance of buffers and type of vegetation cover;
2. control alteration to elevation or contour of the land;
3. specify the location of buildings, fences or structures requiring on-site setbacks.

VEGETATIVE BUFFER ZONES

- *act as sediment and nutrient filters.*
- *prevent streambank erosion.*
- *provide temperature control.*
- *provide food sources.*
- *enhance aesthetics and recreation.*
- *physical barrier to human/ development activities.*

VOLUME CONTROLS

Source controls which reduce the amount of impervious area or restrict the discharge of stormwater to sewers should be used first to achieve specified volume controls. Vegetative and structural best management practices which enhance infiltration are gaining agency and public acceptance. Stormwater quality ponds should be considered as the last line of defense and applied only after all opportunities for infiltration of stormwater have been exhausted.

Daily precipitation records from the AES Bloor Street gauge were examined by Marshal Macklin Monghan (1991) for the twenty year period 1967-1986. This review indicated that 90% of the daily precipitation events were equal or less than 15mm. The majority of the precipitation events are small (less than 5mm) and in undeveloped watershed would produce little if any runoff. In comparison, days with precipitation greater than 25mm are infrequent but represent a significant percentage of the total depth of precipitation [Figure 3].

Baseflow conditions in streams are the low flows which occur during precipitation free period or when precipitation events are small, and do not generate significant runoff. Rainfall free conditions prevail approximately 70% of the time, at the Bloor Street gauge, as shown in Figure 3. Stormwater

TABLE 2 - STORMWATER QUALITY CONTROL GUIDELINES AND WATER USE PROTECTION

Stormwater Quality Control Guidelines

Sensitivity (fisheries)	Buffer Zones (Streams/Lakes)	Volume Controls	Sediment Controls
Coldwater fisheries (sensitive)	30m	25mm daily precipitation	in place during all phases of development and construction
Warmwater fisheries (less sensitive)	15m	13mm daily precipitation	in place during all phases of development and construction

In addition, the following Water Use Protection Guidelines may be required:

Recreation (swimming)	• other than for four discharge occurrences (extreme events) meet 100 fecal coliforms per 100 ml swimming objective.
Aesthetics	• stormwater should be devoid of debris, oil, scum and substances which produce objectionable odour, colour, deposits, or excessive turbidity.
Other Uses:	
Drinking Water, Irrigation, Agricultural, etc.	• directives will be established in consultation with Conservation Authorities, MNR and MOE as the need arises.

FIGURE 2 - URBAN STORMWATER MANAGEMENT SOURCE CONTROLS

(Modified from Marsalek 1990)

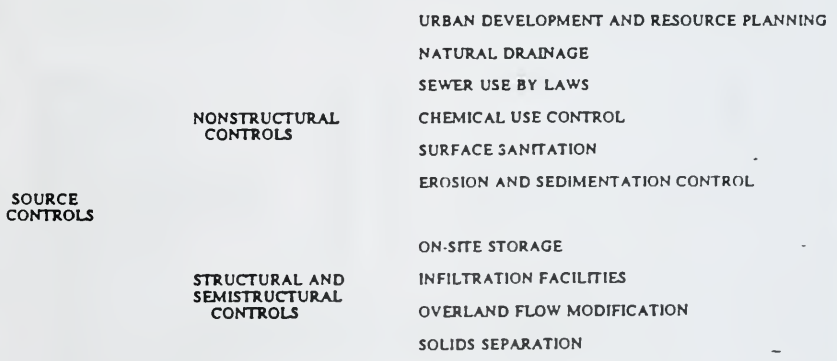


FIGURE 3: DISTRIBUTION OF PRECIPITATION EVENTS, DON RIVER

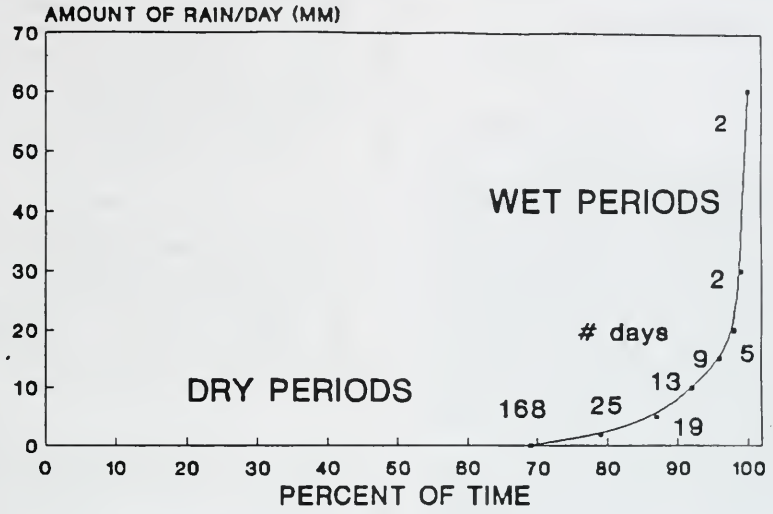


TABLE 3: AVERAGE REMOVAL RATES FOR EXISTING MONITORED RETENTION PONDS IN ONTARIO

Retention Pond	SS	P	N	BOD	Zn	Pb	Fecal
Uplands	79	45					93
Borden Farm	59	48					69
East Barrhaven	52	47					56
Merivale	83	46					87
Hunt Club Ridge	90	63					
Kennedy Burnett (batch)**	98	79	54	36	21	39	99
Kennedy Burnett (cont.)**	93	86	57	57			85
Lake Aquitaine	65	77	47				
Lake Wabukayne	0	25	0				
Mill Pond*	54	79					

Results are averages for all monitored storms
*Results are for the combination of wet pond and natural wetland
**Mass loading results
Source: Marshal Macklin Monaghan (1991)

quality controls are required in order to protect the critical balance between baseflows and storm-driven runoff events. Baseflows periods are sensitive to changes in watershed imperviousness, resulting in lower, low flows when stormwater is transported overland to streams instead of being infiltrated into the ground. During low flow periods, stream dilution capacities for contaminated stormwater are small, resulting in significant stress on aquatic life, and the disruption of recreational opportunities due to degraded water quality.

Target volumes for infiltration should be identified in Master Drainage Plans for follow up in detailed designs for stormwater management plans. The objective in establishing these targets is to ensure that baseflows are maintained. It is recognized that implementation of "average targets" will not be a straight forward. Some initial guidance for infiltration is provided in the Best Management Practices report by Marshal Macklin Monghan (Ltd.) (1991).

Volume control guidelines are to be applied as runoff control limits for a 13 or 25mm daily precipitation totals.

By ensuring that the runoff generated by daily precipitation events of either 13 or 25mm are infiltrated or free of pollutants, acceptable water quality conditions will exist for significant periods of of the year.

FACTORS AFFECTING SUITABILITY OF SOURCE CONTROLS

- *soil permeability;*
- *drainage area served;*
- *local acceptance;*
- *slope;*
- *space restrictions;*
- *land use restrictions;*
- *land use type;*
- *hydrogeologic conditions;*
- *aquifer use.*

These controls are to be applied in the following order:

1) at source (on-site) infiltration techniques;

2) grading that uses natural and/or man-made surface drainage routes to maximize infiltration;

3) structurally controlled infiltration techniques;

4) wet ponds.

SEDIMENT CONTROLS

Sediment and erosion may increase by one thousand fold (or more) during construction phases of new development. Associated with eroded sediments are a variety of nutrients, trace metals and organic pollutants. To be effective, sediment control must be in place throughout all phases of the development and construction process. Techniques for erosion and sediment control are provided in the UDIC 1987 report entitled "Guidelines on Erosion and Sediment Control for Urban Construction Sites". The 40 microns guideline for sediment control is based on best professional judgement with respect to particle settling control design and performance. Performance is considered in terms of the ability to protect fish habitats, and to improve recreational opportunities.

Concentration limits for suspended solids were not adopted in the guidelines. Emphasis, instead is placed on control strategies which keep sediments clean and limit off site transport.

Once the development activities are complete, local municipality/conservation authorities will assume responsibility for the management of sediments.

WATER USE PROTECTION GUIDELINES

Water use protection guidelines of 100 fecal coliform per 100 ml sample are identified in Table 2 for the protection of downstream beaches.

Wet ponds are used to physically treat stormwater for suspended solids and bacteria. In their design and performance review of Ontario retention ponds, Marshal Macklin Monghan (1991) reported high removal rates for bacteria and suspended solids (Table 3). Effluent discharges from these facilities routinely exceeded bacteria guidelines for swimming and bathing use of water. Additional levels of treatment, such as ultra violet or chlorination/de-chlorination will be required in conjunction with stormwater ponds to meet swimming objectives.

BEST MANAGEMENT PRACTICES

'Best Management Practices' (BMPs) has gained wide acceptance as a general term designating procedures for quality and quantity control of stormwater.

Techniques considered to be BMPs:

- *reduce pollutants available for transport by runoff.*
- *reduce amounts of pollutants in runoff before it is discharged.*

BMPs are used to reduce pollutants to:

- *alleviate or mitigate existing water quality concerns; and,*
- *to avoid future problems, where none exist.*

5.0 ENVIRONMENTAL RESPONSE

Continuing work will be required to ascertain environmental response to the stormwater quality control guidelines and to evaluate control performance. Ideally these activities would entail more than straight water quantity/quality sampling. Emphasis should be placed on qualative assessment of guideline performance through field inspection on both developed lands and the receiving streams. Findings from these reviews should be incorporated in updates to appropriate regulations/bylaws, guidelines, design manuals and implementation strategies.

Key components of environmental response reviews would be the inter-agency transfer of information and education, training and public consultation. Information gathered by this program will be used to guide enforcement and research in the developing field of urban stormwater quality management. ■

STORMWATER QUALITY PONDS

Stormwater quality ponds reduce pollutant concentrations through sedimentation and biological processes.

DRY PONDS:
- *flood and erosion control;*
- *limited and ineffective water quality enhancement;*
- *old thinking;*
- *can be retrofitted for water quality control.*

WET PONDS:
- *permanent pool of water;*
- *may provide high removal of suspended particulates;*
- *reduction in nutrients, trace metals and bacteria.*

EXTENDED DETENTION PONDS:
- *modifications to dry ponds to detain water;*
- *ponds to drain in 24 to 48 hours;*
- *minimum storage at other times;*
- *dual role for quantity and quality control.*

ACKNOWLEDGEMENT

These guidelines for stormwater quality control were prepared with the collaboration of many individuals both within and outside the two ministries. Representatives of private consulting firms, Conservation Authorities, local municipalities and the Development Industry provided expert advice and technical assistance during the development phase. Their helpful advice and suggestions are gratefully acknowledged.

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